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A new species of scutacarid mites transferring fungal spores (Acari, Tarsonemina)

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A new species of scutacarid mites transferring fungal spores (Acari, Tarsonemina). - The mite species *Imparipes (I.) breganti* sp. n. (Heterostigmata, Scutacaridae) is described. Females of this species use the atrium genitale as a transport container (sporotheca) for fungal spores. The females have been found phoretic on soil-dwelling sphecids and, less commonly, on soil-dwelling bee species. The male and larva are still unknown. *Imparipes breganti* sp. n. is recorded from a number of collection sites in Austria, Belgium and Germany.

Keywords: Acari - Scutacaridae - new mite species - spore transfer - sporothecae - Sphecidae - wild bees - phoresy.

INTRODUCTION

The transfer of fungal spores via a sporotheca in mites is a rare phenomenon. Even though it has evidently evolved repeatedly, it – as far as our state of knowledge goes – only occurs in few of the heterostigmate families (Lindquist, 1985). In the course of an examination of phoretic mites which mainly were collected from wild bees and sphecids we recently discovered two species of the mite family Scutacaridae that also transport fungal spores by means of a sporotheca (Ebermann & Hall, 2003). Both species, *Imparipes haeseleri* Ebermann & Hall, 2003 and *Imparipes apicola* (Banks, 1914), use their atrium genitale as a transport container for fungal spores. We now also discovered this type of sporotheca in another european scutacarid species of the genus *Imparipes*. The description of this new species is presented in this paper.

MATERIAL AND METHODS

Wild bees, sphecids and slide preparations were placed at our disposal from the following collections: ISNB, OÖLM, LJG, ZMUH.

Localities and hymenopterous hosts

The labelling of samples refers to original labels of microscopic preparations or prepared insects, respectively.

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AUSTRIA: **AUT-BL-2b**: Oberhenndorf N Jennersdorf, S-Burgenland (46°59'N, 16°08'E); *Crossocerus elongatulus* (v. d. Linden, 1829) (Sphecidae): ♀, 25.06.1997, Bregant leg., Gusenleitner det.; (LJG), 1 mite. **AUT-BL-2c**: same as AUT-BL-2b; *Crossocerus ovalis* Lepeletier & Brullé, 1834) (Sphecidae): ♀, 19.05.1997, Bregant leg., Gusenleitner det.; (LJG), 1 mite. **AUT-BL-3**: Weiden bei Rechnitz (47°18'N, 16°21'E), *Hylaeus variegatus* (Fabricius, 1798) ["Prosopis variegatus"] (Apidae): ♀, 21.08.1996, Bregant leg., Hausl-Hofstätter det. (LJG), 3 mites. **AUT-BL-4**: Tauka; *Cerceris rybyensis* (Linnaeus, 1771) (Sphecidae): ♂, 31.07.2000, Gusenleitner leg. & det.; (OÖLM), 1 mite. **AUT-NÖ-1b**: Falkenstein, Dörfl-Glaserberg; *Andrena flavipes* Panzer, 1799 (Apidae): ♂, 13.05.1998, Ruckenstuhl leg., Gusenleitner det.; (OÖLM), 1 mite. **AUT-OÖ-2d**: Plesching near Linz; *Cerceris rybyensis* (Linnaeus, 1771) (Sphecidae): ♀, 29.08.2000, Schwarz leg., Gusenleitner det.; (OÖLM), 2 mites. **AUT-OÖ-5**: Mühlbach S Wilhering; *Cerceris rybyensis* (Linnaeus, 1771) (Sphecidae): ♂, 01.07.1999, Gusenleitner leg. & det.; (OÖLM), 2 mites. **AUT-OÖ-6**: Schabetsberg SE St. Agatha; *Andrena flavipes* Panzer, 1799 (Apidae): ♂, 21.04.2000 Gusenleitner leg. & det.; (OÖLM), 1 mite. **AUT-OÖ-7**: Müllerberg S Bad Schallerbach; *Andrena flavipes* Panzer, 1799 (Apidae): ♂, 07.04.2000, Gusenleitner leg. & det.; (OÖLM), 3 mites. **AUT-OÖ-8**: Weinzierlbruck N Prambachkirchen; *Andrena flavipes* Panzer, 1799 (Apidae): ♂, 21.04.2000, Gusenleitner leg. & det.; (OÖLM), 1 mite. **AUT-ST-3d**: Windische Bühel, Kranach (Menhart), NNE Leutschach (46°41'N, 15°28'E); *Lindenius panzeri* (v. d. Linden, 1829) (Sphecidae): ♀, 29.09.1996, Bregant leg., Gusenleitner det.; (LJG), 1 mite. **AUT-ST-3g**: Kranach NE Leutschach, farm Menhart, S-Styria (46°69'N, 15°48'E; 400 m), *Cerceris sabulosa* (Panzer, 1799) (Sphecidae): ♂, 08.08.1994, Hausl-Hofstätter leg., Bregant det. (LJG), 1 mite. **AUT-ST-9a**: Freienberg SW Stubenberg am See, E-Styria, *Diodontus luperus* Shuckard, 1837 (Sphecidae): ♀, 11.07.1995, Bregant leg. & det. (LJG), 1 mite. **AUT-ST-11a**: Weinburg or W-Styria; *Cerceris rybyensis* (Linnaeus, 1771) (Sphecidae): ♀, Maly leg. & coll., Dollfuss det.; (LJG), 3 mites. **AUT-ST-11b**: same as AUT-ST-11a; AUT-ST-11a; *Gorytes* sp. (Sphecidae): 1 ex., Maly leg. & coll.; (LJG), 10 mites. **AUT-?-1**: Seeboden; *Sphecodes monilicornis* (Kirby, 1802) (Apidae): ♀, 22.07.1909, Ebmer det., Salzmann coll.; (LJG), 1 mite.

BELGIUM: **BEL-5**: Uccle; *Lestica subterranea* (Fabricius, 1775) ["Crabro subterraneus"] (Sphecidae): ♂, 08.06.1946, Crevecoeur; (ISNB), 2 mites. **BEL-6**: Wesembeek; *Osmia papaveris* (Latreille, 1799) (Apidae): ♂, 22.06.1941, Crevecoeur; (ISNB), 1 mite.

GERMANY: **GER-12**: Hosüne; *Diodontus tristis* (v. d. Linden, 1829) (Sphecidae): ♀, 28.06.1903, Haeseler det.; (ZMUH), 4 mites. **GER-13**: Achim near Bremen; *Diodontus tristis* (v. d. Linden, 1829) (Sphecidae): ♂, 30.06.1979, Haeseler det.; (ZMUH), 2 mites. **GER-14**: Bornhausen; *Lindenius albilabris* (Fabricius, 1793) (Sphecidae): ♀, 09.08.1973, Haeseler det.; (ZMUH), 47 mites. **GER-19**: Dingstede; *Crossocerus varus* Lepeletier & Brullé, 1835 ["Crossocerus pusillus"] (Sphecidae): ♀, 08.07.1983, Haeseler det.; (ZMUH), 1 mite. **GER-20**: Quelkhorn near Bremen; *Diodontus tristis* (v. d. Linden, 1829) (Sphecidae): ♂, 09.08.1970, Haeseler det.; (ZMUH), 5 mites.

Abbreviations

Description: aPS = anterior margin of segment PS; Ag = aggenital plate; ap = apodeme; aStpl = anterior sternal plate; b = anterior margin of ge; Fe = femur; ge = genital sclerite; Gen = genu; lTa = length of tarsus; lPrTa = length of pretarsus; n = number; PrTa = pretarsus; PS = segment PS; pStpl = posterior sternal plate; s1, s2 = lateral margins of ge; sol = solenidion; spo = spores; Ta = tarsus; Ti = tibia; TiTa = tibiotarsus; Tr = trochanter; x = average; ≈ about the same length; < = shorter than; > = longer than; ≥ = the same length or longer; ≤ = the same length or shorter; α1, α2, β = enclosed angles of ge.

Localities: AUT = Austria, BEL = Belgium; GER = Germany; *Austrian provinces:* BL = Burgenland, NÖ = Lower Austria, OÖ = Upper Austria, ST = Styria.

Collections: CEE = Collection Ernst Ebermann, Karl-Franzens-University Graz, Austria; HNHM = Hungarian Natural History Museum, Budapest, Hungary; ISNB = Institut Royal des Sciences Naturelles de Belgique, Brussels, Belgium; MHNG = Muséum d'histoire naturelle, Geneva, Switzerland. OÖLM = Oberösterreichisches Landesmuseum, Linz, Austria; LJG = Landesmuseum Joanneum, Graz, Austria; ZMUH = Zoologisches Institut und Zoologisches Museum der Universität Hamburg, Germany.

Preparation and Measurements

The dried phoretic mites were removed from their hymenopterous hosts with the tip of a moistened pencil, then transferred to 70% methanol and embedded in Swan' Medium. We measured the anterior and lateral margins of the genital sclerite and their angles. The calculated values are given as relative values in the descriptions.

RESULTS AND DISCUSSION

Imparipes (Imparipes) breganti sp. n. (female) Figs 1-2, 3a, 4-6

Material: 95 ♀♀ (11 of these were used for molecular-biological analysis: AUT-BL-4, AUT-NÖ-1b, AUT-OÖ-2d, AUT-OÖ-5, AUT-OÖ-6, AUT-OÖ-7, AUT-OÖ-8). Holotype (specimen from AUT-BL-3) and 83 paratypes from 16 localities in Austria, Belgium and Germany (see list of localities). *Deposition*: Holotype and 2 paratypes in MHNG, 81 slides with paratypes in CEE, HNHM, ISNB, MHNG, ZMUH.

Diagnosis: Imparipes breganti sp. n. is most closely related to *Imparipes apicola* (Banks, 1914); both species correspond in following characteristics: Similar setation of venter. Relative length of legs: Leg I < leg II < leg III << leg IV. Relative length of segments of leg IV: lTr to lTi < lTa to lPrTa. The manner of attachment of ge on segment PS. Posession of a sporotheca; similar type of enclosed fungal spores. Association with soil-dwelling hymenoptera. Differences between *I. breganti* and *I. apicola*: Setae of dorsum in *breganti* relatively longer and more slender than in *apicola*. Relative length of setae dTi, tc' and tc" (leg IV): *breganti* dTi > tc' > tc", *apicola*: tc' > dTi > tc". Genital sclerite of *breganti* is generally broader than in *apicola* (Fig. 3a-b).

Description: Body dimensions (measurements given in µm): Idiosoma length: 199 - 230, x = 209 (n = 20), holotype 210; broad (measured in the widest part of seg-

ment C): 146 - 182, x = 161 (n = 20), holotype 158; width of aStpl (measured as distance between insertion points of setae1b): 46 - 52, x = 48 (n = 20), holotype 49; width of pStpl (measured in the widest part laterally of 3c): 86 - 103, x = 94 (n = 20), holotype 96.

Entire surface of body with tiny pores; cupulae ia and ih large, roundish.

Dorsum (Fig. 1): Free margin of tergite C broad, with fine, radiating stripes (not illustrated in Fig. 1); c1 and c2 without alveolar canal. All setae barbed. Setae c1 and c2 somewhat more slender than the other dorsal setae. Identical setae of specimens from different localities moderately differing in length. Relative length of setae (x of 20 specimens): h1 ≈ c2 ≥ c1 ≈ d ≈ f > h2 ≈ e.

Venter (Fig. 2): Gnathosoma: Setae ch1 not extending beyond palpal region; ap1 and ap2 well developed, ap3 weakly sclerotized, ap4 not reaching to acetabula of leg III, a small secondary apodeme present immediately below ap4, ap5 strongly reduced, its outer parts remaining before 4b. Ventral setae moderately varying length. Relative length of setae (x of 20 specimens): 4c > 4b > 3b > 3a ≥ 4a ≥ 3c ≈ 1a > 2a ≥ 1b ≥ 2b. All setae barbed, ps2 and some gnathosomal setae smooth. 2b daggerlike, with only a few barbs. 3b standing somewhat before 3a and 3c, 3a approaching insertion points of 4a, 3b extending to insertion points of 4b. ps1 ≥ ps3 > ps2; distance ps1–ps1 ≥ distance ps2–ps3 (x of 20 specimens).

Genital sclerite (Figs 2, 3a, 4): Strongly sclerotized, on its ventral surface irregularly scattered scratches, its attachment on the anterior margin of segment PS shown in Fig. 3a; anterior margin of segment PS lateral to ge bent backwards as shown in I. apicola; measurement of ge (x of 39 specimens): b ≈ s1 and s2; l < b; β ≈ α1 and α2.

Sporotheca (Figs 2, 4): The sporotheca is a broad, x-shaped hollow cavity anterior and/or lateral to the genital sclerite ("atrium genitale", see Ebermann & Hall, 2003) filled with fungal spores. Opening of sporotheca formed by fissure between posterior margin of aggenital plate (Ag) and the underlying segment PS (Fig. 2).

Frequency of infestation and diameter of spores: 70 of 95 examined specimens (73.7 %) with 2 to 23 spherical fungal spores in the frontolateral and/or laterocaudad area of genital sclerite (Figs 2, 4). In one and the same sporotheca the diameters of spores varying from 3 to 11µm.

Trichobothrium (Fig. 5a): Club-shaped, thin stemmed, with fine scales, outer seta v1 > v2.

Extremities: Relative length (x of 32 specimens): Leg I < leg II < leg III << leg IV. Leg I (Figs 5b, c): Setal formula: Tr 1, Fe 3, Ge 4, TiTa 16, 4 sol; sol ϖ2 slender, longer than tubercle, ϖ1 large, stout, ω2 club-shaped, ω1 similar to ω2 but thicker; relative length of sol (n = 18): w2 ≈ ϖ1 ≥ ω1 ≥ ω2; TiTa with small claw, tip of claw more or less elongated; v'Fe smooth, with thickened tip. Leg II (Fig. 6a): Setal formula: Tr 1, Fe 3, Ge 3, Ti 4 (sol ω), Ta 6 (sol ϖ); Ta with 2 claws and pulvillus. Leg III (Fig. 6b): Setal formula: Tr 1, Fe 2, Ge 2, Ti 4 (sol ω), Ta 6; Ta with 2 claws and pulvillus. Leg IV (Fig. 6c): Setal formula: Tr 1, Fe 2, Ge 1, Ti 4 (sol ω), Ta 4; relative length of tibial/tarsal setae (x of 21 specimens): dTi > tc' > tc" > pv" > pv'. Length ratios between Tr, Ta and PrTa (x of 21 specimens): lTa < lPrTa; lTr to lTi < lTa to lPrTa.

Male and Larva: Unknown.

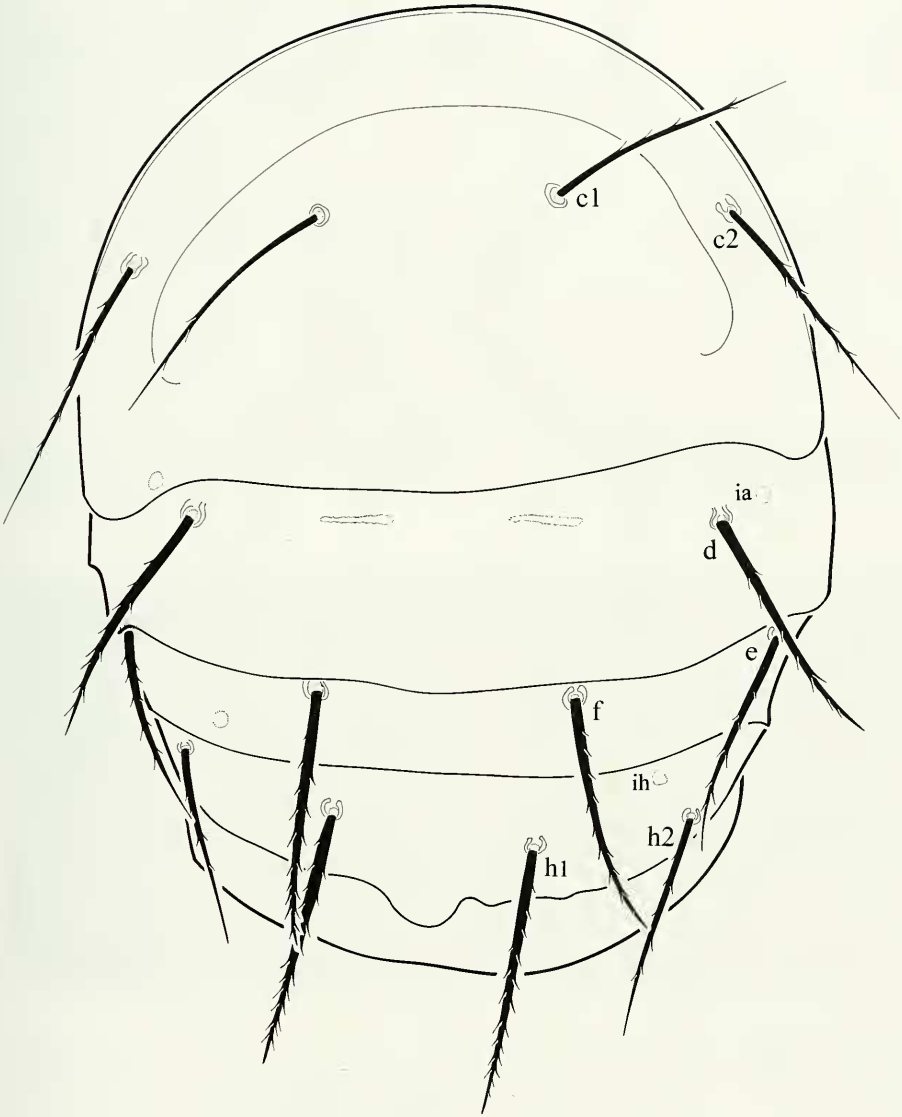

FIG. 1
Imparipes (I.) breganti sp. n., female (holotype), dorsum. Idiosoma length 210 µm.

Bionomics: Phoretic females were mainly found upon soil-dwelling sphecids but also upon soil-dwelling bees.

Etymology: The species name "breganti" is dedicated to the former staff member of the Landesmuseum Joanneum (Graz, Austria), Mr Eugen Bregant (1937-2003), for his entomological research in the eastern part of Austria.

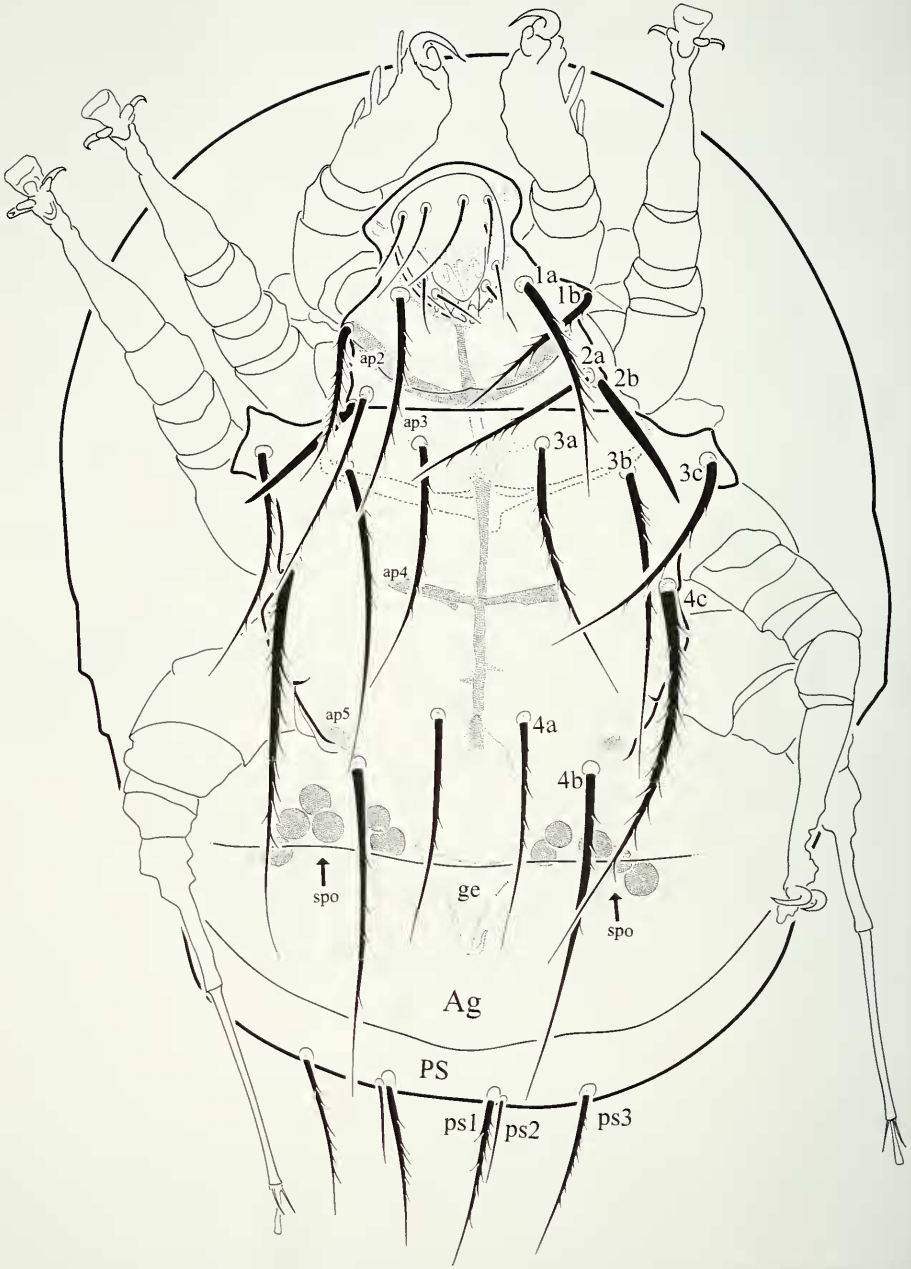

FIG. 2

Imparipes (I.) breganti sp. n., female (holotype), venter; arrows mark the fungal spores (spo) in the atrium genitale.

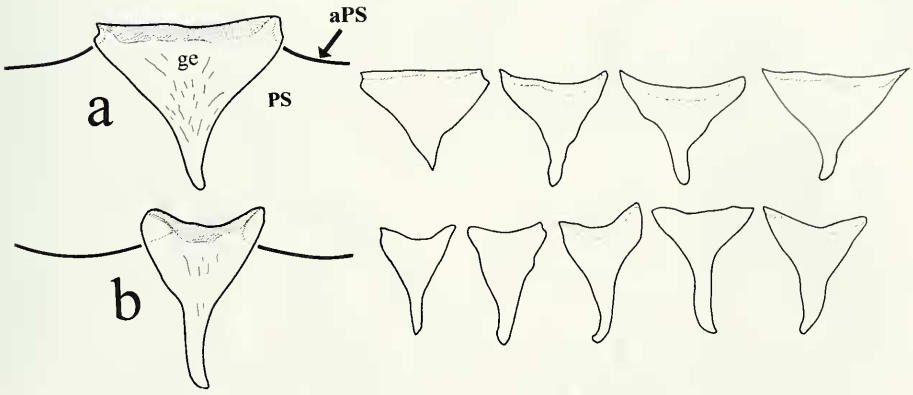

FIG. 3
Genital sclerite (ge): a = *Imparipes breganti* sp. n., b = *I. apicola*. Left: these figures show how the sclerite is anchored to the anterior margin (aPS) of segment PS; right: examples for the variability of ge.

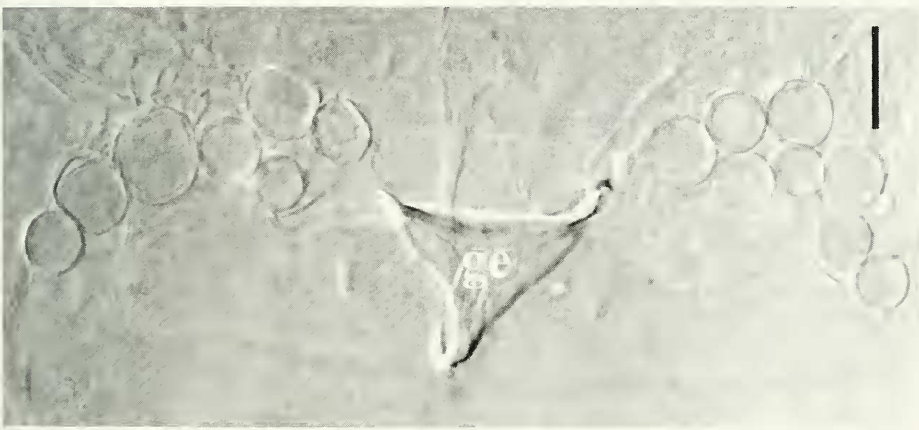

FIG. 4
Imparipes (I.) breganti sp. n., female with 15 fungal spores in the atrium genitale (microphotograph, bar = 10 µm); ge = genital sclerite. Mite from sample GER-13.

TRANSPORT OF FUNGAL SPORES

Imparipes breganti sp. n. has been proven to be yet another scutacarid species transporting fungal spores in a sporotheca. The sporotheca of *I. breganti* sp. n. corresponds to the type which we also detected in *I. haeseleri* and *I. apicola*. The size and shape of the spores corresponds to the Type "B" found in *I. apicola*; the frequency of spore-carrying females of *I. breganti* sp. n. is at 73.7% significantly lower than that in *I. haeseleri* (99.6%) and *I. apicola* (99,1%) (Ebermann & Hall, 2003). Reasons for this are as yet unknown. This third record of a spore-carrying species is an indication that

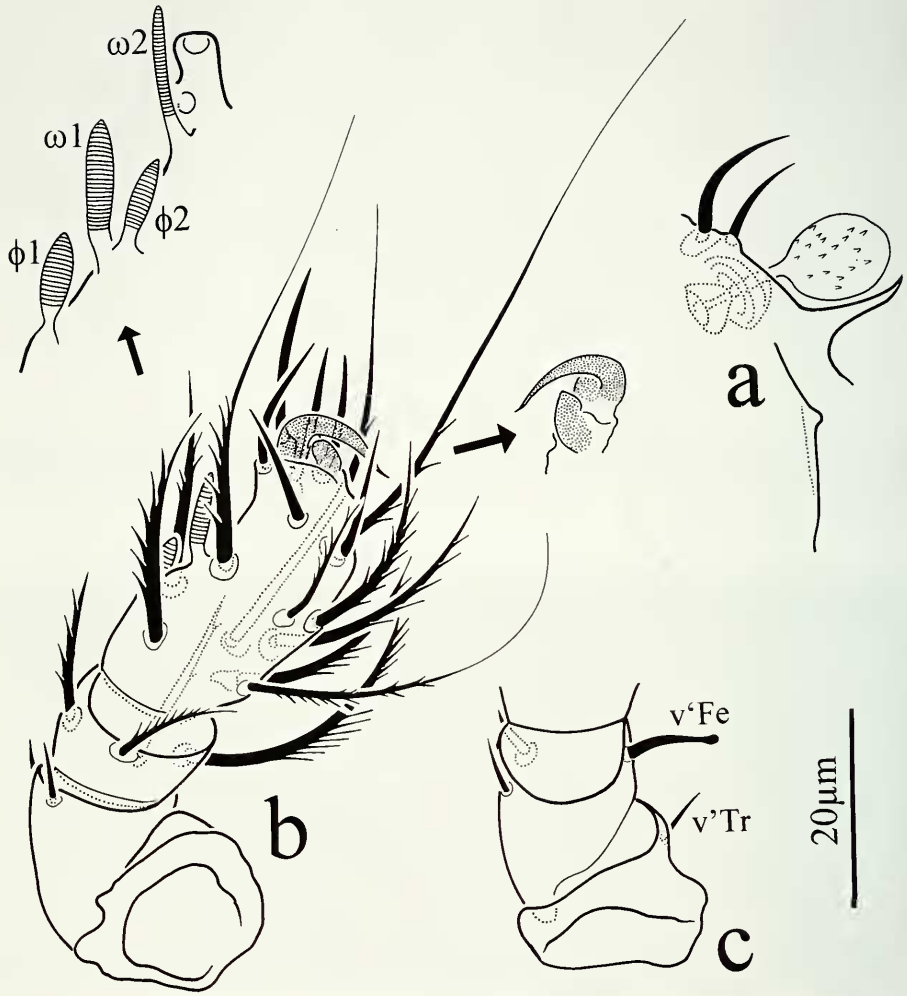

FIG. 5

Imparipes (I.) breganti sp. n., female (a - b = holotype), a = trichobothrium, b = leg I, arrows = claw and solenidia, c = proximal part of leg I of a paratype.

there may potentially be other scutacarid species associated to Aculeata using sporothecae for spore-transfer and that fungi probably play an important role in the mites' cycle of development. In an earlier paper we discussed the potential significance of the sporothecae among the Scutacaridae (Ebermann & Hall, 2003). A solution to the issue is still pending. Further details on the relationship of bee or sphecid hosts and mites, the occurrence of sporothecae and a discussion on zoogeographical aspects will be published elsewhere (Hall & Ebermann, in press).

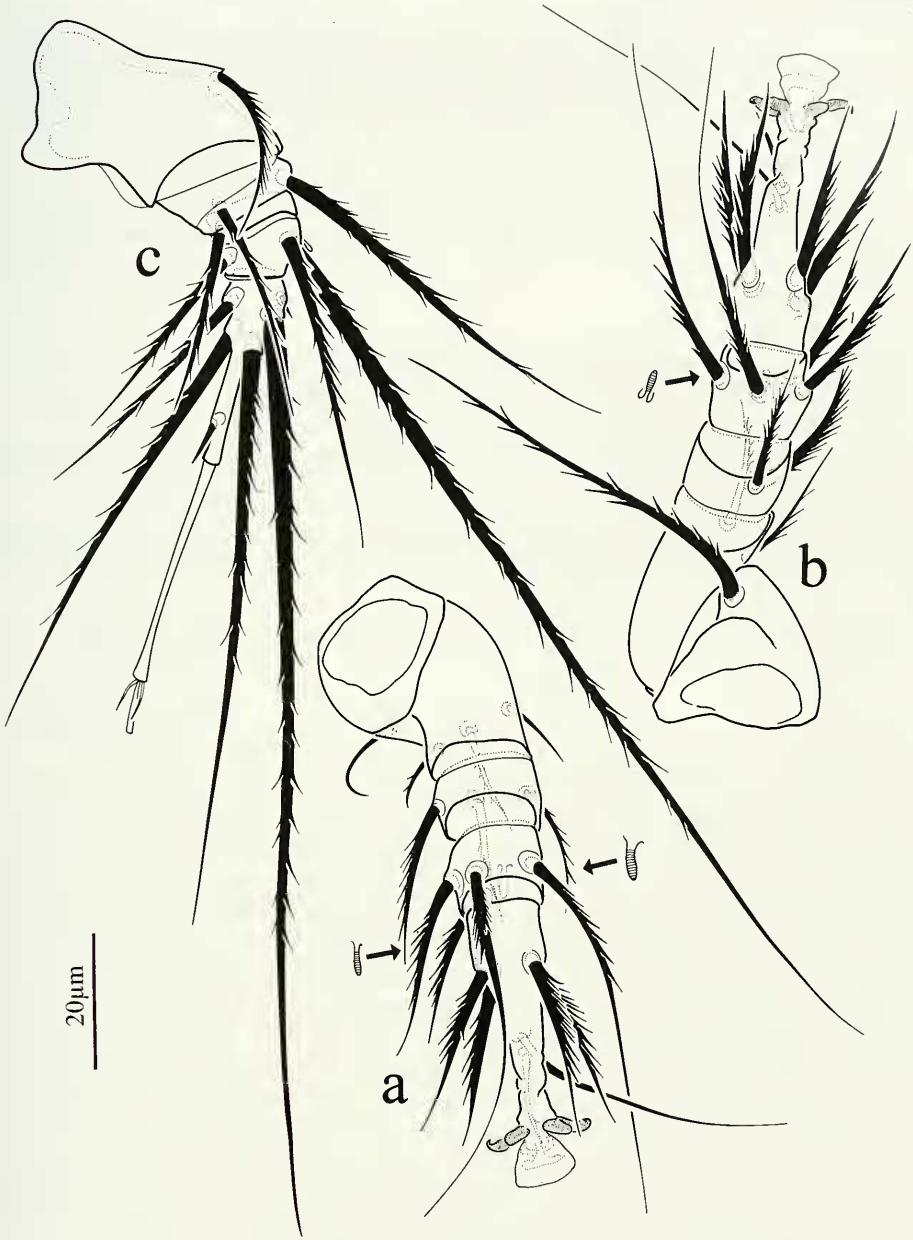

FIG. 6
Imparipes (I.) breganti sp. n., female (holotype): a = leg II, b = leg III, c = leg IV.

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